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(54) **STORAGE ROUTER AND METHOD FOR PROVIDING VIRTUAL LOCAL STORAGE**

(75) Inventors: **Geoffrey B. Hoese**, Austin, TX (US); **Jeffry T. Russell**, Cibolo, TX (US)

(73) Assignee: **Crossroads Systems, Inc.**, Austin, TX (US)

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G06F 13/00 (2006.01)

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See application file for complete search history.

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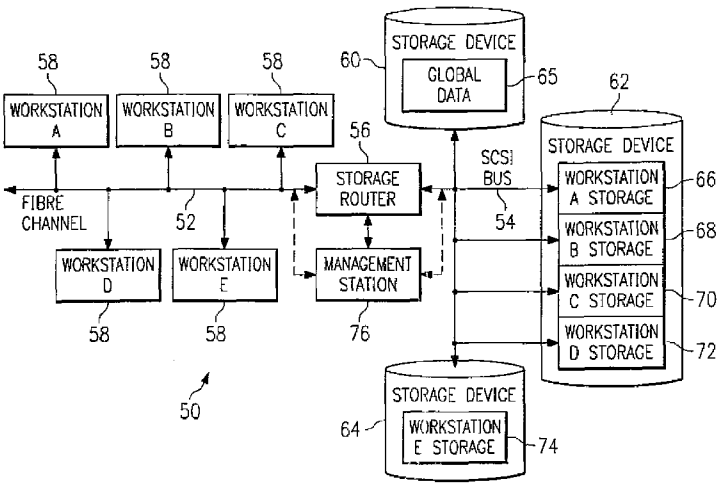
Primary Examiner — Christopher B Shin
(74) *Attorney, Agent, or Firm* — Sprinkle IP Law Group

(57) **ABSTRACT**

A storage router (**56**) and storage network (**50**) provide virtual local storage on remote SCSI storage devices (**60**, **62**, **64**) to Fibre Channel devices. A plurality of Fibre Channel devices, such as workstations (**58**), are connected to a Fibre Channel transport medium (**52**), and a plurality of SCSI storage devices (**60**, **62**, **64**) are connected to a SCSI bus transport medium (**54**) The storage router (**56**) interfaces between the Fibre Channel transport medium (**52**) and the SCSI bus transport medium (**54**). The storage router (**56**) maps between the workstations (**58**) and the SCSI storage devices (**60**, **62**, **64**) and implements access controls for storage space on the SCSI storage devices (**60**, **62**, **64**). The storage router (**56**) then allows access from the workstations (**58**) to the SCSI storage devices (**60**, **62**, **64**) using native low level, block protocol in accordance with the mapping and the access controls.

49 Claims, 2 Drawing Sheets



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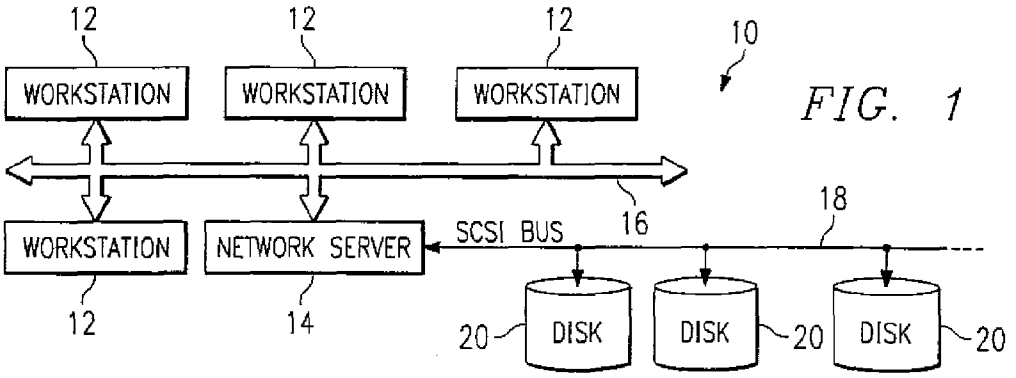

FIG. 1

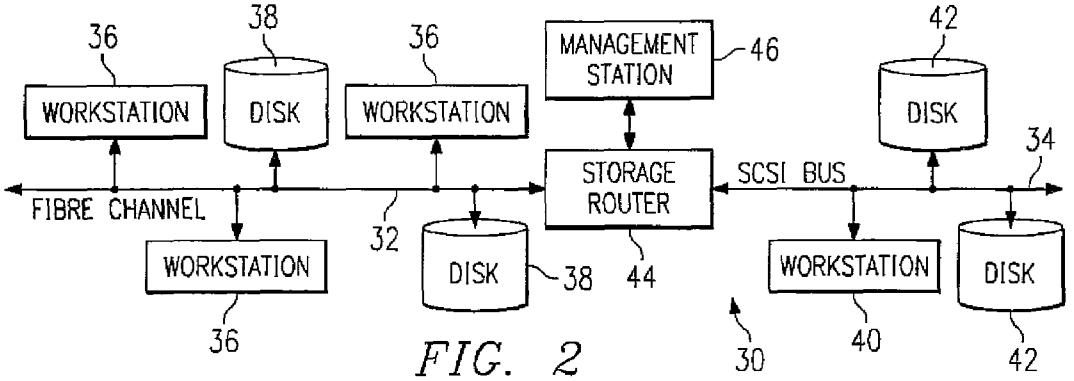

FIG. 2

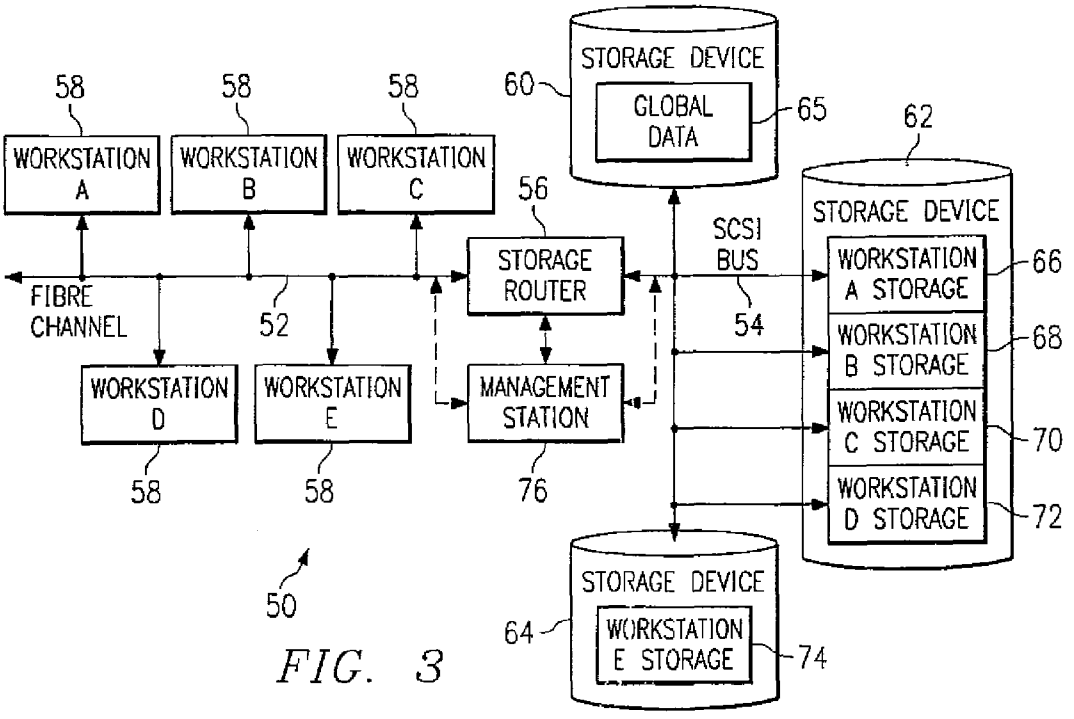

FIG. 3

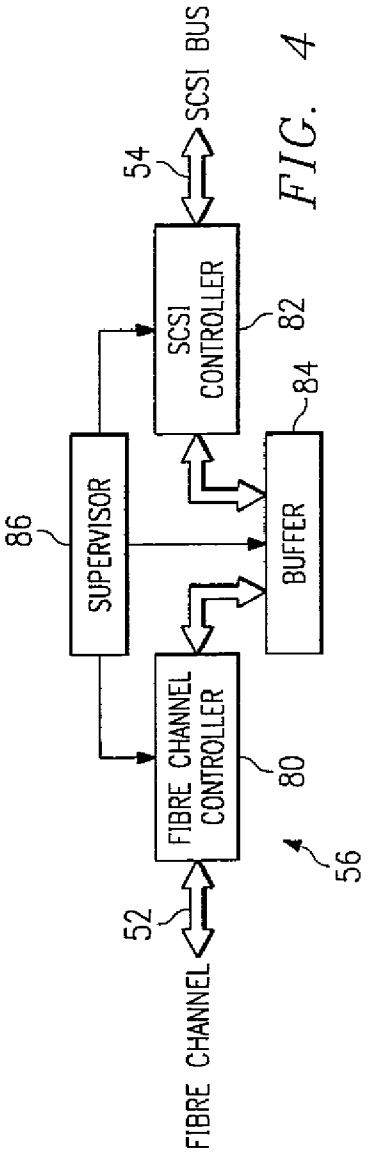
SCSI BUS
54
SCSI CONTROLLER
82
84
BUFFER
86
SUPERVISOR
FIBRE CHANNEL CONTROLLER
80
56
52
FIBRE CHANNEL

FIG. 4

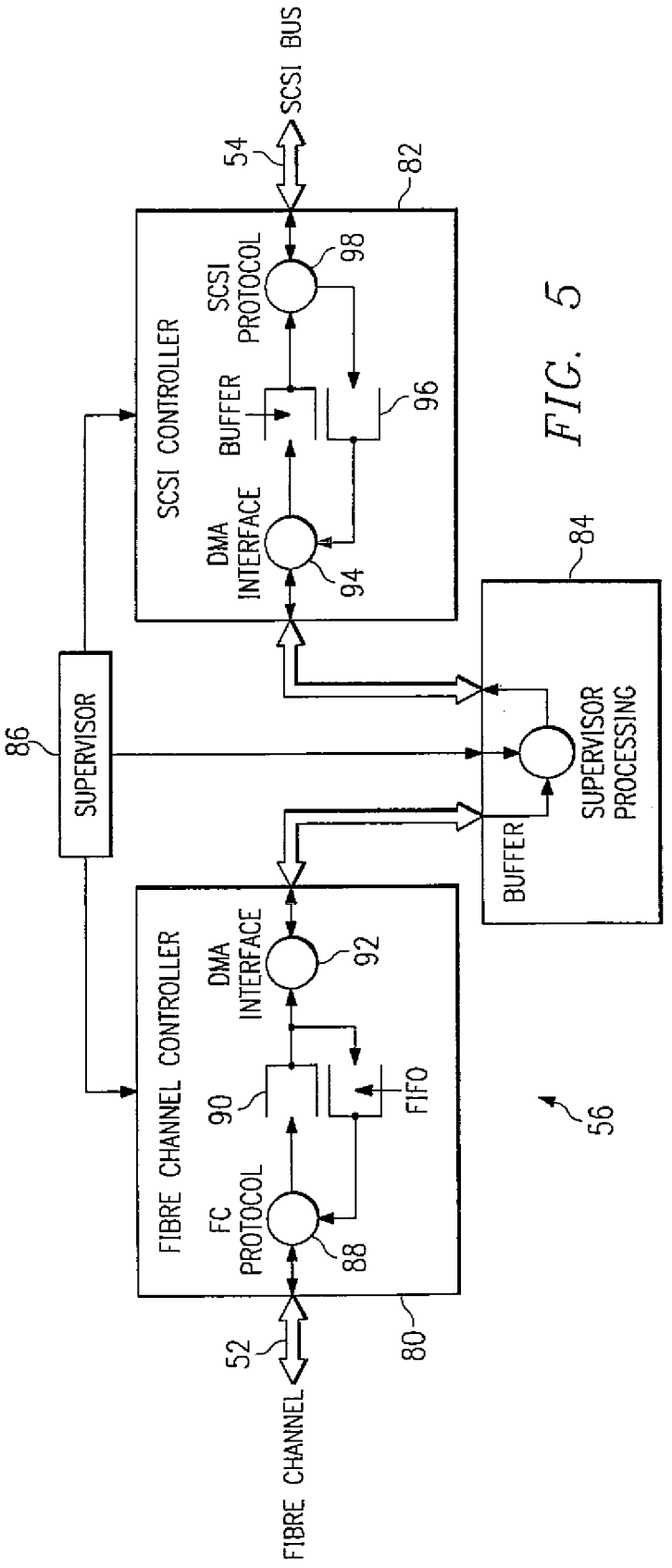
SCSI BUS
54
82
SCSI CONTROLLER
SCSI PROTOCOL
98
BUFFER
96
DMA INTERFACE
94
84
86
SUPERVISOR
BUFFER
SUPERVISOR PROCESSING
FIBRE CHANNEL CONTROLLER
DMA INTERFACE
92
90
FIFO
FC PROTOCOL
88
56
52
80
FIBRE CHANNEL

FIG. 5

STORAGE ROUTER AND METHOD FOR PROVIDING VIRTUAL LOCAL STORAGE

TECHNICAL FIELD OF THE INVENTION

This application is a continuation of, and claims a benefit of priority under 35 U.S.C. 120 of the filing date of U.S. patent application Ser. No. 11/851,724 entitled "Storage Router and Method for Providing Virtual Local Storage" filed Sep. 7, 2007, now U.S. Pat. No. 7,689,754 issued on Mar. 30, 2010 by inventors Geoffrey B. Hoese and Jeffrey T. Russell, which is a continuation of and claims the benefit of priority of U.S. patent application Ser. No. 11/442,878, by inventors Geoffrey B. Hoese and Jeffrey T. Russell, entitled "Storage Router and Method for Providing Virtual Local Storage" filed May 30, 2006 now abandoned, which is a continuation of and claims the benefit of priority of U.S. patent application Ser. No. 11/353,826, by inventors Geoffrey B. Hoese and Jeffrey T. Russell, entitled "Storage Router and Method for Providing Virtual Local Storage" filed on Feb. 14, 2006, now U.S. Pat. No. 7,340,549 issued Mar. 4, 2008, which is a continuation of and claims the benefit of priority of U.S. patent application Ser. No. 10/658,163, by inventors Geoffrey B. Hoese and Jeffrey T. Russell, entitled "Storage Router and Method for Providing Virtual Local Storage" filed on Sep. 9, 2003 now U.S. Pat. No. 7,051,147 issued May 23, 2006, which is a continuation of and claims the benefit of benefit of priority of U.S. patent application Ser. No. 10/081,110 by inventors Geoffrey B. Hoese and Jeffery T. Russell, entitled "Storage Router and Method for Providing Virtual Local Storage" filed on Feb. 22, 2002, now U.S. Pat. No. 6,789,152 issued on Sep. 7, 2004, which in turn is a continuation of and claims benefit of priority of U.S. application Ser. No. 09/354,682 by inventors Geoffrey B. Hoese and Jeffrey T. Russell, entitled "Storage Router and Method for Providing Virtual Local Storage" filed on Jul. 15, 1999, now U.S. Pat. No. 6,421,753 issued on Jul. 16, 2002, which in turn is a continuation of and claims benefit of priority of U.S. patent application Ser. No. 09/001,799, filed on Dec. 31, 1997, now U.S. Pat. No. 5,941,972 issued on Aug. 24, 1999, and hereby incorporates these applications and patents by reference in their entireties as if they had been fully set forth herein.

This invention relates in general to network storage devices, and more particularly to a storage router and method for providing virtual local storage on remote SCSI storage devices to Fibre Channel devices.

BACKGROUND OF THE INVENTION

Typical storage transport mediums provide for a relatively small number of devices to be attached over relatively short distances. One such transport medium is a Small Computer System Interface (SCSI) protocol, the structure and operation of which is generally well known as is described, for example, in the SCSI-1, SCSI-2 and SCSI-3 specifications. High speed serial interconnects provide enhanced capability to attach a large number of high speed devices to a common storage transport medium over large distances. One such, serial interconnect is Fibre Channel, the structure and operation of which is described, for example, in Fibre Channel Physical and Signaling Interface (FC-PH), ANSI X3.230 Fibre Channel Arbitrated Loop (FC-AL), and ANSI X3.272 Fibre Channel Private Loop Direct Attach (FC-PLDA).

Conventional computing devices, such as computer workstations, generally access storage locally or through network interconnects. Local storage typically consists of a disk drive, tape drive, CD-ROM drive or other storage device contained within, or locally connected to the workstation. The workstation provides a file system structure that includes security controls, with access to the local storage device through native low level block protocols. These protocols map directly to the mechanisms used by the storage device and consist of data requests without security controls. Network interconnects typically provide access for a large number of computing devices to data storage on a remote network server. The remote network server provides file system structure, access control, and other miscellaneous capabilities that include the network interface. Access to data through the network server is through network protocols that the server must translate into low level requests to the storage device. A workstation with access to the server storage must translate its file system protocols into network protocols that are used to communicate with the server. Consequently, from the perspective of a workstation, or other computing device, seeking to access such server data, the access is much slower than access to data on a local storage device.

SUMMARY OF THE INVENTION

In accordance with the present invention, a storage router and method for providing virtual local storage on remote SCSI storage devices to Fibre Channel devices are disclosed that provide advantages over conventional network storage devices and methods.

According to one aspect of the present invention, a storage router and storage network provide virtual local storage on remote SCSI storage devices to Fibre Channel devices. A plurality of Fibre Channel devices, such as workstations, are connected to a Fibre Channel transport medium, and a plurality of SCSI storage devices are connected to a SCSI bus transport medium. The storage router interfaces between the Fibre Channel transport medium and the SCSI bus transport medium. The storage router maps between the workstations and the SCSI storage devices and implements access controls for storage space on the SCSI storage devices. The storage router then allows access from the workstations to the SCSI storage devices using native low level, block protocol in accordance with the mapping and the access controls.

According to another aspect of the present invention, virtual local storage on remote SCSI storage devices is provided to Fibre Channel devices. A Fibre Channel transport medium and a SCSI bus transport medium are interfaced with. A configuration is maintained for SCSI storage devices connected to the SCSI bus transport medium. The configuration maps between Fibre Channel devices and the SCSI storage devices and implements access controls for storage space on the SCSI storage devices. Access is then allowed from Fibre Channel initiator devices to SCSI storage devices using native low level, block protocol in accordance with the configuration.

A technical advantage of the present invention is the ability to centralize local storage for networked workstations without any cost of speed or overhead. Each workstation accesses its virtual local storage as if it were locally connected Further, the centralized storage devices can be located in a significantly remote position even in excess of ten kilometers as defined by Fibre Channel standards.

Another technical advantage of the present invention is the ability to centrally control and administer storage space for connected users without limiting the speed with which the users can access local data. In addition, global access to data, backups, virus scanning and redundancy can be more easily accomplished by centrally located storage devices.

A further technical advantage of the present invention is providing support for SCSI storage devices as local storage for Fibre Channel hosts. In addition, the present invention helps to provide extended capabilities for Fibre Channel and for management of storage subsystems.

BRIEF DESCRIPTION OF THE DRAWINGS

A more complete understanding of the present invention and the advantages thereof may be acquired by referring to the following description taken in conjunction with the accompanying drawings, in which like reference numbers indicate like features, and wherein:

FIG. **1** is a block diagram of a conventional network that provides storage through a network server;

FIG. **2** is a block diagram of one embodiment of a storage network with a storage router that provides global access and routing;

FIG. **3** is a block diagram of one embodiment of a storage network with a storage router that provides virtual local storage;

FIG. **4** is a block diagram of one embodiment of the storage router of FIG. **3**; and

FIG. **5** is a block diagram of one embodiment of data flow within the storage router of FIG. **4**.

DETAILED DESCRIPTION OF THE INVENTION

FIG. **1** is a block diagram of a conventional network, indicated generally at **10**, that provides access to storage through a network server. As shown, network **10** includes a plurality of workstations **12** interconnected with a network server **14** via a network transport medium **16**. Each workstation **12** can generally comprise a processor, memory, input/output devices, storage devices and a network adapter as well as other common computer components. Network server **14** uses a SCSI bus **18** as a storage transport medium to interconnect with a plurality of storage devices **20** (tape drives, disk drives, etc.). In the embodiment of FIG. **1**, network transport medium **16** is a network connection and storage devices **20** comprise hard disk drives, although there are numerous alternate transport mediums and storage devices.

In network **10**, each workstation **12** has access to its local storage device as well as network access to data on storage devices **20**. The access to a local storage device is typically through native low level, block protocols. On the other hand, access by a workstation **12** to storage devices **20** requires the participation of network server **14** which implements a file system and transfers data to workstations **12** only through high level file system protocols. Only network server **14** communicates with storage devices **20** via native low level, block protocols. Consequently, the network access by workstations **12** through network server **14** is slow with respect to their access to local storage. In network **10**, it can also be a logistical problem to centrally manage and administer local data distributed across an organization, including accomplishing tasks such as backups, virus scanning and redundancy.

FIG. **2** is a block diagram of one embodiment of a storage network, indicated generally at **30**, with a storage router that provides global access and routing. This environment is significantly different from that of FIG. **1** in that there is no network server involved. In FIG. **2**, a Fibre Channel high speed serial transport **32** interconnects a plurality of workstations **36** and storage devices **38**. A SCSI bus storage transport medium interconnects workstations **40** and storage devices **42**. A storage router **44** then serves to interconnect these mediums and provide devices on either medium global, transparent access to devices on the other medium. Storage router **44** routes requests from initiator devices on one medium to target devices on the other medium and routes data between the target and the initiator. Storage router **44** can allow initiators and targets to be on either side. In this manner, storage router **44** enhances the functionality of Fibre Channel **32**, by providing access, for example, to legacy SCSI storage devices on SCSI bus **34**. In the embodiment of FIG. **2**, the operation of storage router **44** can be managed by a management station **46** connected to the storage router via a direct serial connection.

In storage network **30**, any workstation **36** or workstation **40** can access any storage device **38** or storage device **42** through native low level, block protocols, and vice versa. This functionality is enabled by storage router **44** which routes requests and data as a generic transport between Fibre Channel **32** and SCSI bus **34**. Storage router **44** uses tables to map devices from one medium to the other and distributes requests and data across Fibre Channel **32** and SCSI bus **34** without any security access controls. Although this extension of the high speed serial interconnect provided by Fibre Channel is beneficial, it is desirable to provide security controls in addition to extended access to storage devices through a native low level, block protocol.

FIG. **3** is a block diagram of one embodiment of a storage network, indicated generally at **50**, with a storage router that provides virtual local storage. Similar to that of FIG. **2**, storage network **50** includes a Fibre Channel high speed serial interconnect **52** and a SCSI bus **54** bridged by a storage router **56**. Storage router **56** of FIG. **3** provides for a large number of workstations **58** to be interconnected on a common storage transport and to access common storage devices **60**, **62** and **64** through native low level, block protocols.

According to the present invention, storage router **56** has enhanced functionality to implement security controls and routing such that each workstation **58** can have access to a specific subset of the overall data stored in storage devices **60**, **62** and **64**. This specific subset of data has the appearance and characteristics of local storage and is referred to herein as virtual local storage. Storage router **56** allows the configuration and modification of the storage allocated to each attached workstation **58** through the use of mapping tables or other mapping techniques.

As shown in FIG. **3**, for example, storage device **60** can be configured to provide global data **65** which can be accessed by all workstations **58**. Storage device **62** can be configured to provide partitioned subsets **66**, **68**, **70** and **72**, where each partition is allocated to one of the workstations **58** (workstations A, B, C and D). These subsets **66**, **68**, **70** and **72** can only be accessed by the associated workstation **58** and appear to the associated workstation **58** as local storage accessed using native low level, block protocols. Similarly, storage device **64** can be allocated as storage for the remaining workstation **58** (workstation E).

Storage router **56** combines access control with routing such that each workstation **58** has controlled access to only the specified partition of storage device **62** which forms virtual local storage for the workstation **58**. This access control allows security control for the specified data partitions. Storage router **56** allows this allocation of storage devices **60**, **62** and **64** to be managed by a management station **76**. Management station **76** can connect directly to storage router **56** via a direct connection or, alternately, can interface with storage router **56** through either Fibre Channel **52** or SCSI bus **54**. In the latter case, management station **76** can be a workstation or other computing device with special rights such that storage

router **56** allows access to mapping tables and shows storage devices **60**, **62** and **64** as they exist physically rather than as they have been allocated.

The environment of FIG. **3** extends the concept of single workstation having locally connected storage devices to a storage network **50** in which workstations **58** are provided virtual local storage in a manner transparent to workstations **58**. Storage router **56** provides centralized control of what each workstation **58** sees as its local drive, as well as what data it sees as global data accessible by other workstations **58**. Consequently, the storage space considered by the workstation **58** to be its local storage is actually a partition (i.e., logical storage definition) of a physically remote storage device **60**, **62** or **64** connected through storage router **56**. This means that similar requests from workstations **58** for access to their local storage devices produce different accesses to the storage space on storage devices **60**, **62** and **64**. Further, no access from a workstation **58** is allowed to the virtual local storage of another workstation **58**.

The collective storage provided by storage devices **60**, **62** and **64** can have blocks allocated by programming means within storage router **56**. To accomplish this function, storage router **56** can include routing tables and security controls that define storage allocation for each workstation **58**. The advantages provided by implementing virtual local storage in centralized storage devices include the ability to do collective backups and other collective administrative functions more easily. This is accomplished without limiting the performance of workstations **58** because storage access involves native low level, block protocols and does not involve the overhead of high level protocols and file systems required by network servers.

FIG. **4** is a block diagram of one embodiment of storage router **56** of FIG. **3**. Storage router **56** can comprise a Fibre Channel controller **80** that interfaces with Fibre Channel **52** and a SCSI controller **82** that interfaces with SCSI bus **54**. A buffer **84** provides memory work space and is connected to both Fibre Channel controller **80** and to SCSI controller **82**. A supervisor unit **86** is connected to Fibre Channel controller **80**, SCSI controller **82** and buffer **84**. Supervisor unit **86** comprises a microprocessor for controlling operation of storage router **56** and to handle mapping and security access for requests between Fibre Channel **52** and SCSI bus **54**.

FIG. **5** is a block diagram of one embodiment of data flow within storage router **56** of FIG. **4**. As shown, data from Fibre Channel **52** is processed by a Fibre Channel (FC) protocol unit **88** and placed in a FIFO queue **90**. A direct memory access (DMA) interface **92** then takes data out of FIFO queue **90** and places it in buffer **84**. Supervisor unit **86** processes the data in buffer **84** as represented by supervisor processing **93**. This processing involves mapping between Fibre Channel **52** and SCSI bus **54** and applying access controls and routing functions. A DMA interface **94** then pulls data from buffer **84** and places it into a buffer **96**. A SCSI protocol unit **98** pulls data from buffer **96** and communicates the data on SCSI bus **54**. Data flow in the reverse direction, from SCSI bus **54** to Fibre Channel **52**, is accomplished in a reverse manner.

The storage router of the present invention is a bridge device that connects a Fibre Channel link directly to a SCSI bus and enables the exchange of SCSI command set information between application clients on SCSI bus devices and the Fibre Channel links. Further, the storage router applies access controls such that virtual local storage can be established in remote SCSI storage devices for workstations on the Fibre Channel link. In one embodiment, the storage router provides a connection for Fibre Channel links running the SCSI Fibre Channel Protocol (FCP) to legacy SCSI devices attached to a SCSI bus. The Fibre Channel topology is typically an Arbitrated Loop (FC_AL).

In part, the storage router enables a migration path Fibre Channel based, serial SCSI networks by providing connectivity for legacy SCSI bus devices. The storage router can be attached to a Fibre Channel Arbitrated Loop and a SCSI bus to support a number of SCSI devices. Using configuration settings, the storage router can make the SCSI bus devices available on the Fibre Channel network as FCP logical units. Once the configuration is defined, operation of the storage router is transparent to application clients. In this manner, the storage router can form an integral part of the migration to new Fibre Channel based networks while providing a means to continue using legacy SCSI devices.

In one implementation (not shown), the storage router can be a rack mount or free standing device with an internal power supply. The storage router can have a Fibre Channel and SCSI port, and a standard, detachable power cord can be used, the FC connector can be a copper DB9 connector, and the SCSI connector can be a 68-pin type. Additional modular jacks can be provided for a serial port and an 802.3 10 BaseT port, i.e. twisted pair Ethernet, for management access. The SCSI port of the storage router an support SCSI direct and sequential access target devices and can support SCSI initiators, as well. The Fibre Channel port can interface to SCSI-3 FCP enabled devices and initiators.

To accomplish its functionality, one implementation of the storage router uses: a Fibre Channel interface based on the HEWLETT-PACKARD TACHYON HPFC-5000 controller and a GLM media interface; an Intel 80960RP processor, incorporating independent data and program memory spaces, and associated logic required to implement a stand alone processing system; and a serial port for debug and system configuration. Further, this implementation includes a SCSI interface supporting Fast-20 based on the SYMBIOS 53C8xx series SCSI controllers, and an operating system based upon the WIND RIVERS SYSTEMS VXWORKS or IXWORKS kernel, as determined by design. In addition, the storage router includes software as required to control basic functions of the various elements, and to provide appropriate translations between the FC and SCSI protocols.

The storage router has various modes of operation that are possible between FC and SCSI target and initiator combinations. These modes are: FC Initiator to SCSI Target; SCSI Initiator to FC Target; SCSI Initiator to SCSI Target; and FC Initiator to FC Target. The first two modes can be supported concurrently in a single storage router device and are discussed briefly below. The third mode can involve two storage router devices back to back and can serve primarily as a device to extend the physical distance beyond that possible via a direct SCSI connection. The last mode can be used to carry FC protocols encapsulated on other transmission technologies (e.g. ATM, SONET), or to act as a bridge between two FC loops (e.g. as a two port fabric).

The FC Initiator to SCSI Target mode provides for the basic configuration of a server using Fibre Channel to communicate with SCSI targets. This mode requires that a host system have an FC attached device and associated device drivers and software to generate SCSI-3 FCP requests. This system acts as an initiator using the storage router to communicate with SCSI target devices. The SCSI devices supported can include SCSI-2 compliant direct or sequential access (disk or tape) devices. The storage router serves to translate command and status information and transfer data between SCSI-3 FCP and SCSI-2, allowing the use of standard SCSI-2 devices in a Fibre Channel environment.

The SCSI Initiator to FC Target mode provides for the configuration of a server using SCSI-2 to communicate with Fibre Channel targets. This mode requires that a host system has a SCSI-2 interface and driver software to control SCSI-2 target devices. The storage router will connect to the SCSI-2 bus and respond as a target to multiple target IDs. Configuration information is required to identify the target IDs to which the bridge will respond on the SCSI-2 bus. The storage router then translates the SCSI-2 requests to SCSI-3 FCP requests, allowing the use of FC devices with a SCSI host system. This will also allow features such as a tape device acting as an initiator on the SCSI bus to provide full support for this type of SCSI device.

In general, user configuration of the storage router will be needed to support various functional modes of operation. Configuration can be modified, for example, through a serial port or through an Ethernet port via SNMP (simple network management protocol) or the Telnet session. Specifically, SNMP manageability can be provided via a B02.3 Ethernet interface. This can provide for configuration changes as well as providing statistics and error information. Configuration can also be performed via TELNET or RS-232 interfaces with menu driven command interfaces. Configuration information can be stored in a segment of flash memory and can be retained across resets and power off cycles. Password protection can also be provided.

In the first two modes of operation, addressing information is needed to map from FC addressing to SCSI addressing and vice versa. This can be 'hard' configuration data, due to the need for address information to be maintained across initialization and partial reconfigurations of the Fibre Channel address space. In an arbitrated loop configuration, user configured addresses will be needed for AL_PAs in order to insure that known addresses are provided between loop reconfigurations.

With respect to addressing, FCP and SCSI 2 systems employ different methods of addressing target devices. Additionally, the inclusion of a storage router means that a method of translating device IDs needs to be implemented. In addition, the storage router can respond to commands without passing the commands through to the opposite interface. This can be implemented to allow all generic FCP and SCSI commands to pass through the storage router to address attached devices, but allow for configuration and diagnostics to be performed directly on the storage router through the FC and SCSI interfaces.

Management commands are those intended to be processed by the storage router controller directly. This may include diagnostic, mode, and log commands as well as other vendor-specific commands. These commands can be received and processed by both the FOP and SCSI interfaces, but are not typically bridged to the opposite interface. These commands may also have side effects on the operation of the storage router, and cause other storage router operations to change or terminate.

A primary method of addressing management commands though the FCP and SCSI interfaces can be through peripheral device type addressing. For example, the storage router can respond to all operations addressed to logical unit (LUN) zero as a controller device. Commands that the storage router will support can include INQUIRY as well as vendor-specific management commands. These are to be generally consistent with SCC standard commands.

The SCSI bus is capable of establishing bus connections between targets. These targets may internally address logical units. Thus, the prioritized addressing scheme used by SCSI subsystems can be represented as follows: BUS:TARGET: LOGICAL UNIT. The BUS identification is intrinsic in the configuration, as a SCSI initiator is attached to only one bus. Target addressing is handled by bus arbitration from information provided to the arbitrating device. Target addresses are assigned to SCSI devices directly through some means of configuration, such as a hardware jumper, switch setting, or device specific software configuration. As such, the SCSI protocol provides only logical unit addressing within the Identify message. Bus and target information is implied by the established connection.

Fibre Channel devices within a fabric are addressed by a unique port identifier. This identifier is assigned to a port during certain well-defined states of the FC protocol. Individual ports are allowed to arbitrate for a known, user defined address. If such an address is not provided, or if arbitration for a particular-user address fails, the port is assigned a unique address by the FC protocol. This address is generally not guaranteed to be unique between instances. Various scenarios exist where the AL-PA of a device will change, either after power cycle or loop reconfiguration.

The FC protocol also provides a logical unit address field within command structures to provide addressing to devices internal to a port. The FCP_CMD payload specifies an eight byte LUN field. Subsequent identification of the exchange between devices is provided by the FQXID (Fully Qualified Exchange ID).

FC ports can be required to have specific addresses assigned. Although basic functionality is not dependent on this, changes in the loop configuration could result in disk targets changing identifiers with the potential risk of data corruption or loss. This configuration can be straightforward, and can consist of providing the device a loop-unique ID (AL_PA) in the range of "01h" to "EFh." Storage routers could be shipped with a default value with the assumption that most configurations will be using single storage routers and no other devices requesting the present ID. This would provide a minimum amount of initial configuration to the system administrator. Alternately, storage routers could be defaulted to assume any address so that configurations requiring multiple storage routers on a loop would not require that the administrator assign a unique ID to the additional storage routers.

Address translation is needed where commands are issued in the cases FC Initiator to SCSI Target and SCSI Initiator to FC Target. Target responses are qualified by the FQXID and will retain the translation acquired at the beginning of the exchange. This prevents configuration changes occurring during the course of execution of a command from causing data or state information to be inadvertently misdirected. Configuration can be required in cases of SCSI Initiator to FC Target, as discovery may not effectively allow for FCP targets to consistently be found. This is due to an FC arbitrated loop supporting addressing of a larger number of devices than a SCSI bus and the possibility of FC devices changing their AL-PA due to device insertion or other loop initialization.

In the direct method, the translation to BUS:TARGET: LUN of the SCSI address information will be direct. That is, the values represented in the FCP LUN field will directly map to the values in effect on the SCSI bus. This provides a clean translation and does not require SCSI bus discovery. It also allows devices to be dynamically added to the SCSI bus without modifying the address map. It may not allow for complete discovery by FCP initiator devices, as gaps between device addresses may halt the discovery process. Legacy SCSI device drivers typically halt discovery on a target device at the first unoccupied LUN, and proceed to the next target.

This would lead to some devices not being discovered. However, this allows for hot plugged devices and other changes to the loop addressing.

In the ordered method, ordered translation requires that the storage router perform discovery on reset, and collapses the addresses on the SCSI bus to sequential FSP LUN values. Thus, the FCP LUN values 0-N can represent N+1 SCSI devices, regardless of SCSI address values, in the order in which they are isolated during the SCSI discovery process. This would allow the FCP initiator discovery process to identify all mapped SCSI devices without further configuration. This has the limitation that hot-plugged devices will not be identified until the next reset cycle. In this case, the address may also be altered as well.

In addition to addressing, according to the present invention, the storage router provides configuration and access controls that cause certain requests from FC Initiators to be directed to assigned virtual local storage partitioned on SCSI storage devices. For example, the same request for LUN **0** (local storage) by two different FC Initiators can be directed to two separate subsets of storage. The storage router can use tables to map, for each initiator, what storage access is available and what partition is being addressed by a particular request. In this manner, the storage space provided by SCSI storage devices can be allocated to FC initiators to provide virtual local storage as well as to create any other desired configuration for secured access.

Although the present invention has been described in detail, it should be understood that various changes, substitutions, and alterations can be made hereto without departing from the spirit and scope of the invention as defined by the appended claims.

What is claimed is:

1. A system for providing virtual local storage on remote storage devices to hosts, the system comprising:

remote storage;

an access controller coupled to the remote storage, the access controller comprising:

a first controller operable to connect to and interface with a serial transport medium, wherein when the access controller is connected to the serial transport medium, the access controller is positioned between hosts connected to the serial transport medium and the remote storage so that requests from the hosts to access the remote storage pass through the access controller;

a supervisor unit coupled to the first controller, the supervisor unit operable to:

maintain a map that maps hosts connected to the serial transport medium to subsets of storage space on the remote storage in order to implement centralized access controls to the subsets of remote storage;

process a command received from a host, wherein the command includes a native low level block protocol request for access to a subset of storage;

use native low level block protocol information in the command to determine if the host is allowed access to the requested subset of storage in accordance with the map; and

allow the requesting host to access the requested subset of storage if the requesting host is allowed access to the requested subset of storage.

2. The access controller of claim **1**, wherein the map contains representations of hosts mapped to representations of virtual subsets of storage space representing virtual local storage.

3. The access controller claim **2**, wherein the representations of the hosts are unique identifiers and the representations of the subsets of storage are LUNs.

4. The access controller of claim **3**, wherein the remote storage comprises centralized storage connected to the access controller and the hosts connect to the centralized storage through the access controller.

5. The access controller of claim **3**, wherein the map further maps the LUNs to physical storage locations.

6. The access controller of claim **5**, wherein the mapping of LUNs to physical storage is created at the access controller.

7. The access controller of claim **3**, wherein the host identifications are unique identifications.

8. The access controller of claim **2**, wherein the host identifications are world wide names.

9. The access controller of claim **2**, wherein the access controller is operable to implement access controls to the centralized storage in a manner transparent to the hosts.

10. The access controller of claim **9**, wherein the map can be modified in a manner that does not involve the hosts.

11. The access controller of claim **1**, wherein the access controller is operable to present to each host only the subset of storage mapped to that host.

12. The access controller of claim **1**, wherein the access controller is operable to:

present a LUN to a first host and a second host;

map the presented LUN to different storage locations so that requests for that LUN will be directed to different subsets of storage for the first host and the second host.

13. The access controller of claim **1**, wherein the access controller is operable to:

present a LUN to a first host and a second host;

map the presented LUN to a storage location so that requests for that LUN from the first host and the second host will be directed to the same storage location.

14. The access controller of claim **1**, wherein access is allowed without involving a high level protocol or file system.

15. The access controller of claim **1**, wherein the map only resides at the access controller.

16. The access controller of claim **1**, wherein the remote storage comprises a single storage device.

17. The access controller of claim **1**, wherein the remote storage comprises multiple storage devices.

18. The access controller of claim **1**, wherein the access controller is operable to access the map to determine if a representation for the requesting host is mapped to a representation for the requested subset of storage space.

19. The access controller of claim **1**, wherein the first controller is a fibre channel controller and the supervisor unit comprises a processor coupled to the fibre channel controller.

20. The access controller of claim **1**, wherein the supervisor unit comprises a processor coupled to the first controller.

21. The access controller of claim **20**, wherein the access controller is further operable to connect to a second transport medium.

22. The access controller of claim **21**, wherein the access controller is operable to forward an access request to a storage device providing the requested subset of storage if the requesting host is allowed access to the requested subset of storage without involving a high level protocol or file system.

23. The access controller of claim **1**, wherein the access controller is operable to connect to a second transport medium.

24. The access controller of claim **23**, wherein the second transport medium is operable to carry native low level block protocol communication.

25. The access controller of claim 23, wherein the access controller is operable to forward an access request to a storage device providing the requested subset of storage if the requesting host is allowed access to the requested subset of storage without involving a high level protocol or file system.

26. The access controller of claim 25, wherein forwarding the access request further comprises forwarding a native low level block protocol access request.

27. A method for providing virtual local storage to hosts for remote storage devices, comprising:

providing an access controller coupled to one or more storage devices;

connecting the access controller to a serial transport medium between hosts connected to the serial transport medium and the one or more storage devices so that the one or more storage devices are remote storage for the hosts and requests from the hosts to access the remote storage pass through the access controller;

maintaining a map that maps hosts connected to the serial transport medium to subsets of storage space on the remote storage in order to implement centralized access controls to the subsets of remote storage;

processing a command received from a host, wherein the command includes a native low level block protocol request for access to a subset of storage;

using native low level block protocol information in the command to determine if the host is allowed access to the requested subset of storage in accordance with the map; and

allowing the requesting host to access the requested subset of storage if the requesting host is allowed access to the requested subset of storage.

28. The method of claim 27, wherein the map contains representations of hosts mapped to representations of virtual subsets of storage space representing virtual local storage.

29. The method of claim 28, wherein the representations of the hosts are unique identifiers and the representations of the subsets of storage are LUNs.

30. The method of claim 29, wherein the remote storage comprises centralized storage connected to the access controller and the hosts connect to the centralized storage through the access controller.

31. The method of claim 29, wherein the map further maps the LUNs to physical storage locations.

32. The method of claim 31, wherein the mapping of LUNs to physical storage is created at the access controller.

33. The method of claim 29, wherein the host identifications are unique identifications.

34. The method of claim 28, wherein the host identifications are world wide names.

35. The method of claim 28, further comprising providing the virtual local storage to the hosts in a manner transparent to the hosts such that the virtual local storage has the appearance and characteristics of virtual local storage.

36. The method of claim 28, wherein the access controller is operable to implement access controls to the centralized storage in a manner transparent to the hosts.

37. The method of claim 36, wherein the map can be modified in a manner that does not involve the hosts.

38. The method of claim 27, wherein the access controller is operable to present to each host only the subset of storage mapped to that host.

39. The method of claim 27, further comprising

presenting a LUN to a first host and a second host;

mapping the presented LUN to different storage locations so that requests for that LUN will be directed to different subsets of storage for the first host and the second host.

40. The method of claim 27, further comprising:

presenting a LUN to a first host and a second host;

mapping the presented LUN to a storage location so that requests for that LUN from the first host and the second host will be directed to the same storage location.

41. The method of claim 27, wherein access is allowed without involving a high level protocol or file system.

42. The method of claim 27, wherein the map only resides at the access controller.

43. The method of claim 27, wherein the remote storage comprises a single storage device.

44. The method of claim 27, wherein the remote storage comprises multiple storage devices.

45. The method of claim 27, wherein the access controller is operable to access the map to determine if a representation for the requesting host is mapped to a representation for the requested subset of storage space.

46. The method of claim 27, further comprising coupling the access controller to a second transport medium.

47. The method of claim 46, further comprising forwarding an access request to a storage device providing the requested subset of storage if the requesting host is allowed access to the requested subset of storage without involving a high level protocol or file system.

48. The method of claim 47, wherein the second transport medium is operable to carry a native low level block protocol communications.

49. The method of claim 47, wherein the access request forwarded to the storage device comprises a native low level block protocol access request.

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